



# Growduino user manual

**Version: Growduino V\_2.0-OrPI purchased from 1.9.2018 until now.**

Thank you for purchasing the Growduino. To achieve full satisfaction with this product please follow this user manual as follows.

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## **Connection**

Do not plug in the device into the mains right after you unwrap it. Do not switch it on. Follow further steps as shown in this manual.

In the space selected, install all required sensors into ports as labelled on Growduino. When you hear a click to the connector from both the sensor and Growduino the connection was performed correctly. There is no need for using force, it should allow you to connect it easily. Sensors are not waterproof (except the temperature sensor for irrigation), do not place these near running water, including rain. Use only full copper cables for sensors. When using other than supplied cables, proper functionality can not be guaranteed.

The sensor cables must be routed separately at least 50 cm away from the Growduino power cables as well as for controlled or other devices. This is a necessary condition for eliminating interference and for the sensors to function properly.

## **Information about sensors arrangement**

### **Light1 - Outdoor**

Sensor for measuring amount of light outside the cultivating area. It is used for managing light inside a box/greenhouse, see Output Light. Make sure that direct sun light falls on the box when placing - the grey/brown disc should face towards the sky. Artificial light must not fall onto the sensor, it would distort measured values. At the same time, however it must not be exposed to rain and running water. Ideal placement is inside a greenhouse, preferably on the ceiling.

### **Light2 - Indoor**

Sensor for measuring amount of artificial light produced. It is used for managing light function; see Alert " When Lighting Indoor is... ". Place the box in the close proximity to the lighting with the disk directed towards the source of light. If you use lighting that generates substantial amount of heat (such as vacuum tubes MH or HPS, infra, but also very strong LED or CFL), place the plastic box in sufficient distance to prevent any melting. To check if the distance is ideal, hold your hand there for 5 minutes with no result of burns :-)

### **DHT22 - Temperature1 a Humidity**

Sensor for measuring air temperature and relative humidity. It is used for managing ventilation, see Output Fan. Provided that you use artificial lighting, place it levelled with the tops of the plants. If you do not use artificial lighting, place it between second half and top third of the selected space. Make sure it is not installed in direct light, near any source of heat (light) or amongst dense vegetation; it may cause distorted measurement.

### **Temp2 - Water temperature**

Waterproof sensor for measuring water with fertilizers temperature or water in aquaponic system. It also allows measurement of air temperature, as such you can use it to control temperature of grow space. It manages cooling of aquaponic medium by increasing level of cold water, see Output Refill, or sending information with respect of warm or cold water via mail, see Alert "when Water Temperature is...". Place the sensor where you aim to measure the water temperature. The waterproof part of the sensor starts at the metal tube up to the connection outset into the flat cable.

### **Temp3 - Bulb**

Sensor for measuring air temperature at the lighting, it is used as a thermostat for protection, see Output Light. Place the sensor to such distance from the lighting, until it displays temperature of approximately 50-60°C after heating up. If you use lighting that generates substantial amount of heat (such as vacuum tubes MH or HPS, infra, but also very strong LED or CFL), place the plastic box in sufficient distance to prevent any melting. To check if the distance is ideal, hold your hand therefor 5 minutes with no result of burns :-)

### **Usnd - Ultrasound distance**

Sensor that uses ultrasound to measure distance. It is used for increasing water level control, see Output Refill, but also for notifications of low or excess of water, see Alert "When sensor distance...". Place the sensor on the lid of the water container or above the aquaponic tank at such position so that the cylinder emitter/receiver aims perpendicularly to the water surface.

### **EC - electric conductivity**

Sensor for measuring electric conductivity in liquids. Shows amount of dissolved nutrients. Used for send notifications of low or excess EC. Sensor probe is connected to converter using BNC connector. The converter is not water resistant. Sink the sensor 2-4 cm under water surface. When ordered together with pH sensor, 3D printed floater will be included for free. If necessary, clean the probe gently by ultrasoft toothbrush. This sensor is factory calibrated for use with included cable length. See chapter Calibration.

### **pH - Acidity/Alkalinity**

Sensor for measuring acidity in liquids. Based on measured values You will receive email alert when pH is too high or low. Sensor probe is connected to converter using BNC connector. The converter is not water resistant. Sink the sensor 2-4 cm under water surface. When ordered together with EC sensor, 3D printed floater will be included for free. If necessary, rinse the probe gently a stream of water. This sensor is factory calibrated for use with included cable length. See chapter Calibration.

### **CO2 - Carbon dioxide**

Sensor for measuring amount of CO2 in air. Based on measured values You can drive electronic valve and dispense CO2 into your grow area. Of course You will receive email alert when CO2 is too high or low.

The resolution is 1 PPM, range 0-40000 PPM. For the most effective measurement, place the sensor freely in the room, away from the valve mouth, other sensors or lighting. The sensor will heat up for about 30 minutes after switching on, and the wrong location would distort other sensor measurements and also CO2 measurements.

This sensor is factory calibrated for the purchased unit and the cable length used. See chapter Calibration.

## **Activation**

1. To prevent any electrical hazards and due to assumed high humidity, place the central Growduino unit away from the cultivating area.
2. Plug the ethernet cable into the last port on Growduino marked ETH. The other end of the cable is to be plugged into your router/switch. This will allow you to connect to your home LAN network. On the side of Growduino, there is MAC address for DHCP server. IP address is set to automatic and will be obtained from DHCP server on your router. IP can be changed later on the configuration page.
3. If for some reason the Growduino IP address does not correspond with address range of your LAN, it is necessary to set the range up on your PC/notebook. Then you may change the IP as required in the Growduino web configuration. For further information, please, contact your IT specialist.
4. Plug 230V cable in and switch Growduino on. Display will light up, a text SETUP DONE, CONNECTED and information about obtained IP address will appear. As soon as the red LED control light indicating sensors reading dies out, Growduino is ready for use. Then last measured values appear on the display. To wait 5 minutes for stabilize sensor reading (30 minutes for CO2) is recommended.
5. Supported browser is Google Chrome. Input IP address of your Growduino in the browser, such as 192.168.1.23 . Once the application is loaded (it can take a few seconds), you should then see a page with graphs according to the current values of the sensors read from the memory. If you need to adjust the setting, continue via "Settings".

## **Deactivation**

1. Always turn off Growduino only when red diode signalizing sensor reading do not lit. If You try to turn off Growduino during measure and write cycle, data can be corrupted and Growduino may not work properly after that.
2. Switch Growduino off with switch on the side, near 240V power cable.
3. If your Growduino is equipped with internal UPS, push the "UPS OFF" button for about 15 seconds until display goes out to switch off completely.

## How Growduino works

### Measuring and recording of data

Growduino, is above sensors and relay with outlet sockets also equipped with a control microcomputer. In regular minute intervals, this microcomputer recalculates measured data by the sensors and saves them into internal database. It simultaneously, evaluates user settings and switches output sockets ON or OFF accordingly. Every measurement, saving and evaluating of data lasts about 10-20 seconds. During this period of time Growduino is not accessible from the network, that can cause longer waiting for data to display. However the LED control light on Growduino is either on or is flashing whilst in process of measuring or saving.

Warning – when the LED control light is on and a cycle of measuring and saving data, do not switch off or reset Growduino, you would damage data.

### Display

Selection of information which may appear on the display:

Air Temp – temperature of air from sensor DHT22

Humidity – relative air humidity from sensor DHT22

Water Temp – temperature form sensor Temp2 (waterproof)

Water level – distance in cm from water surface to sensor USND

Etc...

At a start up, various information about the system Growduino appear, such as initialisation and completion of the start up cycle ("DONE.").

### Webserver-client

There also runs a program on the micro computer of Growduino, it responds to network requests, so called Webserver. When you type your Growduino IP address your browser address bar, webserver responds, sends it to your PC page (client, client application). During loading, the display shows "Loading application...". This application will run in the browser and requests measured data from Growduino whilst displaying "Loading backend status...". Once all the data are uploaded by the browser, it is displayed as a web page. Page Sensors displays first.

The left bar is used for switching between pages:

Sensors – default page with graphs and information of connected outputs

Outputs – page for output settings according to measured values

Alerts – page for alert settings to emails

Settings – Growduino system settings, see introduction

Calibration – some of sensors calibration

Maintenance – backup, delete, upload

Warning – the application has got the same layout regardless what sensors and outputs you purchased. Please ignore any graphs or outputs, which are not connected.

## **Sensors**

Page “Sensors” is the primary page showing measured values of sensors.

### **Graphs**

It is possible to zoom certain parts in graphs, either with a mouse or a finger on touch devices. The time graph shows data measured every minute – how the measuring cycles run. Daily graph displays hourly averages, monthly graph displays daily averages.

Thus, it is possible to display various periods by clicking on Month, Day, Hour Calendar and arrows left and right. A button with a pictogram of a house returns you back to the current data. It is however dependent on previously selected calendar Month, Day or Hour. That means, when you press DAY and select a certain day in past and then you click on the house, the current day will display. When you press HOUR and select a certain hour in past and then you click on the house, the current hour will display. Calendar responses equally – it depends if you wish to select hours, days or whole months. On the right from the arrows you see date and time of displayed data.

### **Relay state history**

In the left column, under page switches, there are individual output devices displayed. If they are grey, output is switched off. Green means output is switched on. Relay state history is displayed underneath them – entries referring to connected outputs.

As well as at graphs, you can browse relay state history. Depending on the internet or LAN connection speed and number of relay changes during the day it can take a few seconds to display selected hour/day. Relays history is not working in month browsing mode.

## Outputs

This page is used for setting up output devices:

Under each output, there are buttons for manual switch on and off or over to automatic control according to setting.

Warning – total load of all outputs at one time must not exceed 10A, that is for 230V max 2300W.

Important - when setting time range, the day starts at 00:00 and ends at 24:00.

Examples:

When You need to shine a light from midnight to six AM, set 00:00-06:00.

When You need to shine a light from 8PM to midnight, set 20:00-24:00.

When You need to shine a light from 10PM to 10AM (through night), set 22:00-10:00.

### **Light**

Intelligent light control

Growduino allows switching lights on according to light volume outdoors, it is suitable for example when adding light in a greenhouse out of season or early in the morning or evening. To allow this, purchase of Light sensor 1 Outdoor is necessary.

Press tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Condition is: Switch on, at time from xx:xx to xx:xx and light outside is less than xx, leave switched on until light outside increases above xx.

Example – we know, that sunrise starts approx. at 4am, however it does not shine with full intensity onto the green house until 9am. Until then Light Outdoor in the graph shows maximum of 60. In the evening the sun sets already at 7pm, however we need the light on the plants till 10pm. Settings would be then: Switch on, when time is from 04:00 to 22:00 and light outside less than 50, leave switched on until light intensity increases to 60. Then click Save on the bottom of the page. As soon as the settings are saved, "Save successful" appears on the display. For cancellation click on the "no parking" sign and save.

Note: values 50 and 60 from the example above adjust to your own conditions directly at the location. Their extent also determines hysteresis required to prevent lighting switching on and off too often, such as cloud movement on the sky. Light will turn off automatically whenever light outdoors exceeds set value or after set time period will come to an end.

Lighting thermostat

Once the function is active, light does not switch on until temperature from sensor Temp3 falls under set temperature. Press tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set required temperature above which the lighting must not switch on. Then click Save on the bottom of the page. As soon as the settings are saved, "Save successful" appears on the display. For cancellation click on the "no parking" sign and save.

Note: You may place the sensor on tips of the plant leaves to prevent any switching light on unless there is too warm in that area thus protecting plants from overheat or burn (caused by ventilator damage, no further heat from lights will be generated into the space).

Standard timer

You can set up standard digital timer with assistance of +add interval. Press +add interval, input time from and to. Then click Save on the bottom of the page. As soon as the settings are saved, "Save successful" appears on the display. You can set up several intervals, if required. For cancellation press cross sign and save.

## Fan - Ventilation

Thermostat preventing too much intake of cold air

Growduino does not permit switching the ventilation on if the temperature in the silvicultural space (Air Temperature) is too low. It can protect the plant in case a window is left opened which would otherwise allow a dangerously cold air being sucked into the silvicultural space.

Condition is: Never turn on the ventilation if the temperature is below  $xx^{\circ}\text{C}$ .

Press tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired temperature below which the ventilation can not be switched on. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Maintaining the desired temperature

Growduino allows to maintain the temperature range in the silvicultural area through ventilation. You can set different conditions for day and night mode.

Condition is: Switch the ventilation on at time from  $xx:xx$  to  $xx:xx$  and when the temperature exceeds  $xx^{\circ}\text{C}$  and ventilate until it falls below  $xx^{\circ}\text{C}$  or the time runs out.

Press tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired temperature range to be maintained. Range is important because of hysteresis for the ventilation not to switch on and off too often. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Maintaining the required humidity

Growduino allows to maintain the humidity range in the silvicultural area through ventilation. You can set different conditions for day and night mode.

Condition is: Switch the ventilation on at time from  $xx:xx$  to  $xx:xx$  and when humidity exceeds  $xx\%$  and ventilate until it falls below the  $xx\%$  or the time runs out.

Press tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired humidity range to be maintained. Range is important because of hysteresis for the ventilation not to switch on and off too often. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Maintaining max CO<sub>2</sub> concentration

Growduino allows to maintain maximum CO concentration in the silvicultural area through ventilation. You can set different conditions for day and night mode.

Condition is: Switch the ventilation on at time from  $xx:xx$  to  $xx:xx$  and when CO<sub>2</sub> exceeds  $xxx\text{PPM}$  and ventilate until it falls below the  $xxx\text{PPM}$  or the time runs out.

Press tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired CO<sub>2</sub> range to be maintained. Range is important because of hysteresis for the ventilation not to switch on and off too often. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Intelligent timer

Growduino, in addition to temperature and humidity control allows periodic switching on of the output FAN - Ventilation. It is important when both temperature and humidity are within the specified limits but you still wish to ventilate the enclosed silvicultural room and increase e.g. air quality inside. You can set different conditions for day and night mode.

Condition is: At time from  $xx:xx$  to  $xx:xx$  switch on every  $xx$  minutes and leave running for  $xx$  minutes or until the time runs out.

Press the tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will



activate. Set the desired interval and switching time. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Example: I want the entire space to be ventilated every 15 minutes. I know my ventilator can handle 250 m<sup>3</sup>/hour, which is, according to the conversion, approximately 4m<sup>3</sup>/minute. The size of the space is 2x1x2m, i.e. 4 m<sup>3</sup> - 1 minute should therefore suffice for a complete air exchange. I set Growduino's intelligent timer for: every 15 minutes ventilate for 1 minute.

Note: always enter only whole minutes in the first field. For example, if you need to time it for 2 hours, enter 120 (2x60).

#### Standard timer

You can set the standard digital timer by + add interval. Press + add interval, enter the time from and time to. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. There can be more intervals set if needed. To cancel press the hashtag and then save.

### Humidifier

Growduino lets you increase the humidity in the silvicultural area as per settings.

Condition is: Switch output for humidifier on, when humidity drops below xx% and humidify until it reaches xx%. Press the tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired humidity range to be maintained. Range is important because of hysteresis so the humidification didn't switch on and off too often. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

#### Intelligent timer

Growduino allows periodic switching on of the output Humidifier.

Condition is: Switch on every xx minutes and leave running for xx minutes.

Press the tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired interval and switching time. Then, at the bottom of the page, press Save.

Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

#### Standard timer

This output has a standard timer as well, it is set in the same way as FAN - ventilation.

### Watering/Irrigation

Irrigation is switched on using an intelligent or standard timer.

#### Pump fuse

It is possible to set the fuse against depletion of the water in the tank so that the pump does not run without water.

The condition is: Never switch on irrigation if the water surface distance from the USND sensor is more than xx cm.

Press the tick symbol on the wheel, change to stand-by, and the field for switching conditions are activated. Set the desired maximum distance. Then click on the bottom of the page to save. Once the settings are saved, the message "Save successful" is displayed. To cancel, press the ban to stay and then save.

Intelligent timer

This output has an intelligent timer as well, it is set up in the same way as HUMIDIFIER.

Example: I wish to irrigate 6 times a day and I know that thanks to the power of the pump and piping diameters of the tubes 2 minutes will be enough for it to be sufficiently watered. So I set the timer to run every 240 minutes (24 hours / 6 = every 4 hours, i.e. every 240 minutes), and irrigate for 2 minutes. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Standard timer

This output has a standard timer as well, it is set in the same way as FAN - ventilation.

## Refill

Growduino allows refilling the water tank based on measuring the distance of the sensor from the water surface by a pump or a solenoid valve. It is also possible to add cold water into the aquaponic system if the fish tank is too hot in the summer months.

NB: If you want to use refilling with conditions, it is necessary to purchase USND sensor (ultrasonic distance measurement) or Temperature sensor 2 - waterproof temperature sensor.

Condition 1: Start refilling when the water surface is from the sensor more than xx cm and stop refilling when it is reduced to xx cm (water surface is rising closer to sensor).

Condition 2: Start refilling when the water temperature is higher than xx ° C and stop when it falls to xx ° C.

Press the tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired distance range for the water surface to be maintained. Range is important because of hysteresis so the refilling didn't switch on and off too often, for example due to water ripples. Or, set the temperature you want to maintain. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

NB: There is no need to set both conditions, set which you want to use. In case of refilling the water because of temperature, it's better to have an overflow drain.

Intelligent timer

This output has an intelligent timer as well, it is set in the same way as HUMIDIFIER.

Standard timer

This output has a standard timer as well, it is set in the same way as FAN - ventilation.

## Heating

Growduino allows heating of the silvicultural area on the basis of temperature measurement (sensor DHT22). This heating is particularly suitable for lower wattage, such as heating pads, but can be used for a smaller heater (when ordering ask for the heatsink for SSR relay, however, it must be specified that the overall wattage of Growduino must not exceed a total maximum of 2300W).

The condition is: Turn on the heating when the air temperature falls below xx ° C and heat until the temperature reaches xx ° C.

Press tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired temperature range to be maintained. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Intelligent timer

This output has an intelligent timer as well, it is set in the same way as HUMIDIFIER.

Standard timer

This output has a standard timer as well, it is set in the same way as FAN - ventilation.

## Water Heating

Growduino allows heating of water, fertilizer/nutrient solution or aquaponic tank on the basis of temperature measurement (sensor Temp2 - water). This heating is particularly suitable for lower wattage, such as aquarium heater. If power drain is 250W or more, ask for the heatsink for SSR relay when ordering. However, it must be specified that the overall wattage of Growduino must not exceed a total maximum of 2300W.

The condition is: Turn on the heating when the water temperature falls below xx ° C and heat until the temperature reaches xx ° C.

Press tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired temperature range to be maintained. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Intelligent timer

This output has an intelligent timer as well, it is set in the same way as HUMIDIFIER.

Standard timer

This output has a standard timer as well, it is set in the same way as FAN - ventilation.

## Dehumidifier

Growduino allows switching on dehumidifier based on the measurement of relative humidity using sensor DHT22.

NB: It is necessary to use such a dehumidifier which does not require microswitch button control to switch it on - one that simply requires plugging into the socket or rocker switch to be switched on, with manual control (AC-5488 Tristar, STEBA LE 100 Master DH 711). To drive a dehumidifier which does require microswitch button control to switch it on, contact technical support at Growduino web pages.

The condition is: Switch dehumidification on when the humidity is greater than XX% and dehumidify until it falls to xx%.

Press tick symbol in the circle, it changes to "no stopping" and conditions for switching fields will activate. Set the desired humidity range to be maintained. Range is important because of hysteresis for the dehumidifier not to switch on too often. Then, at the bottom of the page, press Save. Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Intelligent timer

This output has an intelligent timer as well, it is set in the same way as HUMIDIFIER.

Standard timer

This output has a standard timer as well, it is set in the same way as FAN - ventilation.

## CO2 Dispenser

Allows You to dose a CO2 gas using electromagnetic valve into silvicultural area. It's driven by CO2 sensor. Measuring cycle is one minute, use of a needle adjusted valve is recommended for fine dosing. Intelligent condition settings prevents to open the valve during ventilation running.

Condition 1 is: Never open the valve if the temperature is over xx °C.

Condition 2 is: Never open the valve if the humidity is over xx %.

Condition 3 is: Switch the valve on at time from xx:xx to xx:xx and when CO2 falls below xx ppm and leave open until it exceeds the xx ppm or the time runs out.

Intelligent timer

This output has an intelligent timer as well, it is set in the same way as HUMIDIFIER.

Standard timer

This output has a standard timer as well, it is set in the same way as FAN - ventilation.

### **FreeTimer**

This output is useful, for example, for blowing on plants – wind simulation, lighting using special lamps, regular oxygenation of the filler/grout using air stones, mixing the water with nutrients in the water tank using a circulating pump ... the possibilities are open.

Intelligent timer

This output has an intelligent timer as well, it is set in the same way as HUMIDIFIER.

Example: I want to simulate wind every 20 minutes so it blows for the duration of 2 minutes. So I select to run every 20 minutes and leave on for 2 minutes. Then, at the bottom of the page, press Save.

Once the settings are saved, the message "Save successful" will display. To cancel, press "no stopping" and then save.

Standard timer

This output has a standard timer as well, it is set in the same way as FAN - ventilation.

## **Alerts**

For the option of sending notices the Settings page is required to be filled in as follows:

SMTP server - Growduino can send emails only without the user being logged on, i.e. you need your server provider to allow you to send mails from inside of the network without the need to login. Enter the IP address of the server, not the DNS name. For more information, contact your Internet provider.  
SMTP port - normally 25. For more information, contact your Internet provider.

System name - enter up to 8 characters.

E-mail from - enter the email address of the sender, this may be fictional but must have a valid format ([something@something.something](mailto:something@something.something)) and real existing domain. We recommend an existing/your second address to fill in, in such case of undeliverable alert it will be returned to this address.

### **How do Alerts work**

After setting the conditions within the minute measuring and storing cycle, Growduino finds that the condition was met / exceeded and sends an e-mail with the text from the field "On message". Once the measured value in subsequent cycles drops below the set value, it sends an email with the text from field "Off message".

**Condition:** When the value exceeds xx, send an email to xx@xx.xx with the text xx. Once it falls below the set value in the first field, send an email with the text xx.

**Example 1:** I have a USND sensor for the distance from surface of water in water tank and I want to receive alerts when the water is running out. According to the size of the container I know that, for example, the 40cm distance of the surface from the sensor means that the water will run out soon. So I set up Alert "When sensor distance is over" 40cm, then my email and into the text fields I enter "Water running out!" and "Water level is OK again".

Saving and deactivating works in the same way as with the outputs control. Set the alerts one at a time.

**Tip:** Using the Alert for water level, you can also tell whether the pump hasn't used up all the water at once. If you know you filled up yesterday and as such it should not have been used up today, and Growduino reports that it has, it is time for spatial check.

**Example 2:** I have a sensor Light sensor 2 (indoor) located under the light and want to check whether the lighting works as it should. So I set the alert "When Indoor Lighting is below" ("When the amount of light is less than") to e.g. 70 and I set the time for the period when the light is supposed to be controlled according to the settings on the Outputs page. I fill in the texts for On message "Light is not on but should be!" and Off message "The light is on again." Likewise, you can fill in the opposite Alert "When Lighting Indoor is over" ("When the amount of light is greater than"), for example, set the value to 70, only in the time field I set the values for the light to switch off.

**Tip:** Using Alert "When Lighting Indoor is over", when the value setting is low, you can be notified via email if there is outside light penetrating the silvicultural area.

## List of Alerts

When the air temperature rises above xx  
When the air temperature falls below xx  
When the water temperature rises above xx  
When the water temperature drops below xx  
When the humidity rises above xx  
When the humidity falls below xx  
When the distance between the sensor and the level rises above xx  
When the distance between the sensor and the level drops below xx  
When the light is not working when it should  
When light is on when it should not  
When pH rises above xx  
When pH falls below xx  
When EC rises above xx  
When EC falls below xx  
When CO2 rises above xx at a certain time  
When CO2 falls below xx at a certain time  
When battery capacity falls below xx  
When there is a power outage

## Settings

On the Settings page, you can manually fill in the fields for:

- a. DHCP checkbox - when checked, IP address, Netmask and Gateway address will be obtained automatically from DHCP server, typically a home router.
- b. HTTPS\* checkbox - when checked, solely encrypted secure communication will be used and Growduino will require password logon. Default login name and password are "grdw", written without quotation marks.
- c. IP, Netmask and Gateway - can be manually filled and will work only if DHCP checkbox is not checked.
- d. NTP\*\* server - from where Growduino obtains the exact Internet time.
- e. Time zone - in which time zone you are in. Allows to set summer or winter time, if present.
- f. SMTP server\*\*\* - server for sending email Alert e-mails (see Alerts).
- g. SMTP port - port for sending e-mail Alerts, must match SMTP Security settings.
- h. SMTP Security - option for encrypted or unencrypted Alerts e-mails. If anything except "NonSecured port 25" is selected, SMTP Username and SMTP Password must be filled in.
- i. SMTP Username - login username to server for sending Alerts e-mails. Typically the entire e-mail address.
- j. SMTP Password - password for login to server for sending Alerts e-mails.
- k. System name – what is your Growduino called (this name is written into Alerts e-mail).
- l. E-mail from - who is the sender of the e-mail, SMTP servers require some. Some providers check the domain if exists. Using actual real existing e-mail address is recommended.
- m. Wifi SSID - Access point identifier
- n. Wifi password - Access point Wifi password

Please pay attention to accuracy for entered data. Entering incorrect data can lead to unavailability of Growduino on the network or malfunction of certain functionalities. Click on Save, the settings are saved. The settings will take effect after minute or two, Growduino will reset itself automatically.

Reset to default settings

Push the blue button RESET located on the side of Growduino and hold it for 15 seconds, then release. Default settings will work afret minute or two, Growduino will reset itself automatically. After reset there is DHCP checked, HTTPS unchecked and login name and password se to "grdw", written without quotation marks.

### \* HTTPS

For technical reasons, secure communication on a device with a changeable IP address is solved using the so-called Self Signed Certificate. These certificates are not authenticated by an external Certification Authority, so the browser can evaluate them as untrusted/unsecured. This authentication has no effect on the functionality of encrypted communications. To continue working with Growduino, confirm in the browser that you want to enter the page despite the warning.

To set a certificate as trustworthy using MS Internet Explorer:

After logon to HTTPS Growduino click in the address bar on "Certificate error" and then "View certificates".

In the Certificate PopUp window click on "Install Certificate", then click "Next".

Choose "Place all certificates in the following store" and click "Browse".

Choose "Trusted Root Certificate Authorities", click "Ok" and then "Next", on the next screen click "Finish".

Confirm Security Warning by clicking "Yes".

When notification "Import was successful" appears, click "OK" and restart all internet browsers. The certificate error should no longer appear.

#### \*\* NTP

It must be a server in the country You are in, go to <https://www.ntppool.org> for the list and select the continent you are on. Then select the country you are in from the list. Copy the zone name to the "NTP server" field on the Settings page. Example: For the UK it is "uk.pool.ntp.org".

#### \*\*\* SMTP

It must be the SMTP server through which you can send mail without authentication of the username and password ( your provider's internal SMTP server usually allows this) or SMTP server with user authentication, like Gmail, or Seznam, etc. For any further information about SMTP settings please contact your internet provider or visit appropriate mail service FAQ.

Gmail may need additional security settings, please visit this article:

<https://support.google.com/accounts/answer/6010255?hl=en>

## SMTP settings procedure

1. On the Settings page, fill in the required information in the "System name" (required) and "E-mail from" fields (mandatory, provider usually requires a existing and true sender address).
2. Next, fill in all the fields in the SMTP section with the information you obtain from your Internet provider and e-mail service provider and click "Send test email".
3. Fill in the recipient's address and click "Send". The browser will display "Response Received", click OK.
4. If an error message appears, check the information provided or consult with your Internet or e-mail service provider.
5. If the error message does not appear, check the recipient's mailbox in another window / tab. You should find a test e-mail in received messages.
6. Click "Save" to save the settings.

## Wifi connection procedure

1. On the Settings page, click "Scan for wifis", all available 2.4GHz networks will appear.
2. Select the desired network by clicking and, if secure, fill in the login password.
3. Click on "Connect". If the login informations are correct, after a few seconds the "Connected" LED lights up. In the web interface in the DHCP leases section of your router, you can find out what IP address your Growduino has acquired and then control it the same way as over a LAN cable.
4. If you want to disable wifi, delete the filled Wifi SSID and Wifi password and click "Save" to save.



## **Calibration**

Sensors shipped together with basic unit are factory calibrated. As soon as cable length, power source or sensor is changed, recalibration is needed. We also suggest recalibrate once per month, the probes should wear out and may slightly change their properties with an impact on the measurement accuracy. The calibration setting will take effect at the first subsequent measurement.

### **Light-Out a Light-In calibration**

It's a two-point calibration method. It is done by determining the minimum and maximum amount of light. The calibration procedure is the same for both sensors. Decimal places are written with a decimal point, not a comma.

Procedure:

1. Place the sensor in a dark environment. Ideally enclose in an opaque box so that no light can penetrate in.
2. On the "Calibration" page, click the "Calibrate" button next to the appropriate sensor to open the PopUp window, click "Get raw data" for "Calibration pair 1".
3. Wait for the value in the "Sensor data" field to be read, then type 1 in the "Real value" field.
4. Click "Save" to save the settings.
5. Place the sensor in an environment with maximum lighting. Ideally for direct sunlight at noon on a clear summer day.
6. Repeat from step 2, this time for "Calibration pair 2".
7. Wait for the value in the "Sensor data" field to be read, then type 99 in the "Real value" field.
8. Click "Save" to save the settings.
9. Now the sensor is calibrated and should display the appropriate 1 or 99\* values in the graphs when measuring darkness or maximum light.

Note:

\*Light sensors are analog, not digital. This in practice means the possibility of a slight deviation of the measurement depending on the surrounding electromagnetic disturbance and the cable length, therefore the measurement is indicative, not laboratory accurate.

### **DHT22-Temp calibration**

It's a two-point calibration method. It is done by determining the minimum and maximum temperature with verification according to the standard. The standard is a reference accurate and calibrated thermometer with an external sensor. Decimal places are written with a decimal point, not a comma.

Procedure:

1. Connect the sensor and place it together with the standard in the controlled area. Ideally in a closed box with no flowing air and close together. The temperature in this enclosure must be below the lower limit of the expected range in normal operation \*. For example, 10°C.
2. Wait until you see a steady temperature in the charts on the "Sensors" page for at least 5 minutes.

3. On the "Calibration" page, click the "Calibrate" button next to the appropriate sensor to open the PopUp window, click "Get raw data" for "Calibration pair 1".
4. Wait for reading the value in the "Sensor data" field, then enter the value measured by the standard into the "Real value" field.
5. Click "Save" to save the settings.
6. Place the sensor together with the standard in the controlled area. Ideally in a closed box with no flowing air and close together. The temperature in this enclosure must be above the upper limit of the expected range during normal operation \*. For example, 40°C.
7. Wait until you see a steady temperature in the charts on the "Sensors" page for at least 5 minutes.
8. On the "Calibration" page, click the "Calibrate" button next to the appropriate sensor to open the PopUp window, click "Get raw data" for "Calibration pair 2".
9. Wait for reading the value in the "Sensor data" field, then enter the value measured by the standard into the "Real value" field.
10. Click "Save" to save the settings.
11. The sensor is now calibrated and should show the same temperature as the standard\*\* when measuring in a controlled area.

Note:

\* Calibration can be based on different temperatures, but the expected temperatures during normal operation should always be within the calibrated range between Calibration pair 1 and Calibration pair 2.

Example - assume that the measured temperature range will be 15-35°C during normal operation, so set the calibration values below 15°C and above 35°C, 10°C and 40°C is sufficient.

\*\* Deviation is possible within the chapter "Further information", section "Scale, resolution and accuracy of sensors".

## DHT22-Hum calibration

It's a two-point calibration method. It is done by determining the minimum and maximum relative humidity with the standard verification. The standard is a saline solution for 33% and 85% relative humidity \*. Decimal places are written with a decimal point, not a comma.

Procedure:

1. Connect the sensor and place it in a closed RH container of 33% at 20°C.
2. Keep as long as you do not see steady humidity changes in the charts on the "Sensors" page for at least 30 minutes.
3. On the "Calibration" page, click the "Calibrate" button next to the appropriate sensor to open the PopUp window, click "Get raw data" for "Calibration pair 1".
4. Wait for reading the value in the "Sensor data" field, then enter the value measured by the standard (33) into the "Real value" field.
5. Click "Save" to save the settings.
6. Connect the sensor and place in a closed RH 85% container at 20°C.
7. Keep as long as you do not see steady moisture changes in the charts on the "Sensors" page for at least 30 minutes.
8. On the "Calibration" page, click the "Calibrate" button next to the appropriate sensor to open the PopUp window, click "Get raw data" for "Calibration pair 2".
9. Wait for reading the value in the "Sensor data" field, then enter the value measured by the standard (85) into the "Real value" field.
10. Click "Save" to save the settings.

11. The sensor is now calibrated and should show the same humidity as the standard\* when checking in a controlled area.

Solution 33%RH at 20°C

Prepare a supersaturated slurry of salt with distilled water so that all the salt is wet, but the water must not form a continuous level above the salt layer. 50-100g of salt is sufficient.

<https://www.verkon.cz/laboratorni-chemikalie-penta/chlorid-horecnaty-hexahydrat/>

Salt MgCl<sub>2</sub>·6H<sub>2</sub>O - Magnesium Chloride Hexahydrate - Magnesium chloride

Solution 85%RH at 20°C

Prepare a supersaturated slurry of salt with distilled water so that all the salt is wet, but the water must not form a continuous level above the salt layer. 50-100g of salt is sufficient.

<https://www.verkon.cz/laboratorni-chemikalie-lachner/chlorid-draselny/>

Salt KCl - Potassium Chloride - Potassium chloride

Note:

\* Other commonly used salts can be used for calibration, however, the expected humidity in normal operation should always be within the calibrated range between Calibration pair 1 and Calibration pair 2. Also precisely calibrated hygrometer can be used as a standard.

Moisture calibration is time-consuming, and can take 4-12 hours to stabilize.

There are multiple guides for calibrating on the Internet, such as:

<https://www.allaboutcircuits.com/projects/how-to-check-and-calibrate-a-humidity-sensor/>

Table of temperature dependence on relative humidity

Saturated Salt Solution	Temperature (°C)										
	0	5	10	15	20	25	30	35	40	50	60
Relative Humidity over the Salt Solution (%)											
Ammonium nitrate			75	70	67	64	60	53			
Ammonium sulphate	82	82	82	82	81	81	81	80	80	79	
<b>Magnesium chloride</b>	34	34	33	33	<b>33</b>	33	32	32	32	31	29
Magnesium nitrate	60	59	57	56	54	53	51	50	48	45	
Lithium chloride	11	11	11	11	11	11	11	11	11	11	11
Potassium sulphate	99	98	98	98	98	97	97	97	96	96	
Potassium nitrate	96	96	96	95	95	94	92	91	89	85	
<b>Potassium chloride</b>	89	88	87	86	<b>85</b>	84	84	83	82	81	80
Potassium acetate			23	23	23	23	22				
Potassium hydroxide		14	12	11	9	8	7	7	6	6	5
Sodium chloride	76	76	76	76	75	75	75	75	75	74	75
Sodium nitrite					65	64	63	62	61		
Sodium dichromate	61	59	57	57	55	54	53	51	50	49	47

Source: [https://www.engineeringtoolbox.com/salt-humidity-d\\_1887.html](https://www.engineeringtoolbox.com/salt-humidity-d_1887.html)

\*\* Deviation is possible within the chapter "Further information", section "Scale, resolution and accuracy of sensors".

## Temp-Water and Temp-Bulb calibration

It's a two-point calibration method. It is done by determining the minimum and maximum temperature with verification according to the standard. The standard is a reference accurate and calibrated thermometer with an external sensor. The calibration procedure is the same for both sensors. Decimal places are written with a decimal point, not a comma.

Procedure:

12. Connect the sensor and place it together with the standard in the controlled area. Ideally in a closed box with no flowing air and close together. The temperature in this enclosure must be below the lower limit of the expected range in normal operation \*. For example, 10°C.
13. Wait until you see a steady temperature in the charts on the "Sensors" page for at least 5 minutes.
14. On the "Calibration" page, click the "Calibrate" button next to the appropriate sensor to open the PopUp window, click "Get raw data" for "Calibration pair 1".
15. Wait for reading the value in the "Sensor data" field, then enter the value measured by the standard into the "Real value" field.
16. Click "Save" to save the settings.
17. Place the sensor together with the standard in the controlled area. Ideally in a closed box with no flowing air and close together. The temperature in this enclosure must be above the upper limit of the expected range during normal operation \*. For example, 40°C.
18. Wait until you see a steady temperature in the charts on the "Sensors" page for at least 5 minutes.
19. On the "Calibration" page, click the "Calibrate" button next to the appropriate sensor to open the PopUp window, click "Get raw data" for "Calibration pair 2".
20. Wait for reading the value in the "Sensor data" field, then enter the value measured by the standard into the "Real value" field.
21. Click "Save" to save the settings.
22. The sensor is now calibrated and should show the same temperature as the standard\*\* when measuring in a controlled area.

Note:

\* Calibration can be based on different temperatures, but the expected temperatures during normal operation should always be within the calibrated range between Calibration pair 1 and Calibration pair 2.

Example - assume that the measured temperature range will be 15-35°C during normal operation, so set the calibration values below 15°C and above 35°C, 10°C and 40°C is sufficient.

\*\* Deviation is possible within the chapter "Further information", section "Scale, resolution and accuracy of sensors".

## USND - water level calibration

It's a two-point calibration method. It is done by determining the minimum and maximum distance with verification according to the standard. The standard is a tape measure or ruler. Decimal places are written with a decimal point, not a comma.

Procedure:

1. Attach the sensor and position it with the standard perpendicular to the flat surface. Ideally against the wall. The distance to the surface must be below the lower limit of the expected range in normal operation \*. For example, 15cm.

2. Wait until You see a steady distance without changes for at least 5 minutes in the "Sensors" graphs.
3. On the "Calibration" page, click the "Calibrate" button next to the appropriate sensor to open the PopUp window, click "Get raw data" for "Calibration pair 1".
4. Wait for reading the value in the "Sensor data" field, then enter the value measured by the standard into the "Real value" field.
5. Click "Save" to save the settings.
6. Connect the sensor and position it with the standard against the flat surface. Ideally against the wall. The distance to the surface must be above the lower limit of the expected range in normal operation \*. For example, 90cm.
7. Wait until You see a steady distance without changes for at least 5 minutes in the charts on the "Sensors" page.
8. On the "Calibration" page, click the "Calibrate" button next to the appropriate sensor to open the PopUp window, click "Get raw data" for "Calibration pair 2".
9. Wait for reading the value in the "Sensor data" field, then enter the value measured by the standard into the "Real value" field.
10. Click "Save" to save the settings.
11. Now the sensor is calibrated and should show the same distance as the standard\*\* in the control measurement in the controlled area.

Note:

\* Calibration can be done based on different distances, but the expected distances during normal operation should always be within the calibrated range between Calibration pair 1 and Calibration pair 2.

Example - assume that the measured range of the distance from the water level will be 20-80cm, so the calibration values should be set below 20cm and above 80cm, 15cm and 90cm is sufficient.

\*\* Deviation is possible within the chapter "Further information", section "Scale, resolution and accuracy of sensors".

## EC calibration

EC calibration is two point with offset. It is done using calibration solutions with value EC 1,278 and EC 4,523 at a liquid temperature of 20°C.

Solution EC 1,278 , Hanna code HI7031L

<http://hannainst.com/hi7031l.html>

Solution EC 4,523 , Hanna code HI7039L

<http://hannainst.com/hi7039l.html>

Procedure:

1. Both solutions need to have temperature of 20°C
2. Sink the probe into EC 1,278 solution for about 2-4cm under surface. Please ensure it do not contact sides or bottom of container. On the Calibration page click corresponding "Get raw data" button. Repeat this measure until it's stable enough. Then click Save.
3. Repeat this procedure for EC 4,523 solution.
4. Sink the probe into clear water, let a few measure cycles run, look at the values in graphs on the Sensors page. Value of clear water should be 0,3-0,4 EC. If not, set an offset on calibration page, try 1 or -1 and let measure cycle run again. Depending on result, set offset value higher or lower until desired value 0,3-0,4 EC is measured.
5. Now the sensor is calibrated and control measurement of all solutions should be OK.

## **pH calibration**

pH calibration is two point. It is done using calibration solutions with value pH 4,00 and pH 7,03 at a liquid temperature of 20°C.

Solution pH 4,00 , Hanna code HI7004L

<http://hannainst.com/hi7004l.html>

Solution pH 7,03 , Hanna code HI7007L

<http://hannainst.com/hi7007l.html>

Procedure:

1. Both solutions need to have temperature of 20°C
2. Sink the probe into pH 4 solution for about 2-4cm under surface. Please ensure it do not contact sides or bottom of container. On the Calibration page click corresponding "Get raw data" button. Repeat this measure until it's stable enough. Then click Save.
3. Repeat this procedure for pH 7 solution.
4. Now the sensor is calibrated and control measurement of both solutions should be OK.

## **CO2 calibration**

CO2 calibration is two point. Very high accuracy is not possible without laboratory equipment (CO2 and O2 chamber, gas chromatograph), so there is a procedure using statistically proven values.

Procedure:

1. Let the sensor heat up for 15 minutes after switch on.
2. Place the sensor into a well ventilated room. Ideally calibrate outside, out of urban area, open-air, in the shadow and no wind, temperature about 20°C. Environment like this has 400 PPM CO2 concentration.
3. On the Calibration page click corresponding "Get raw data" button. Repeat this measure until it's stable enough. Then click Save.
4. Place the sensor into a small closed area, like plastic bag. Fill the bag with CO2 gas (for example from a carbonated beverage maker). Or You can breathe into a bag - perform as many breaths and puffs until You feel dizzy. This is a sign of high CO2 and low oxygen concentration. Seal the bag and click corresponding "Get raw data" button now for CO2 PPM 40K. Then click Save.
5. Now the sensor is calibrated and should measure about 400 PPM on fresh air. The value may vary depending on wind, movement of persons, environment, breathing persons close to sensor, etc - it is very sensitive.

## **Maintenance**

On the Maintenance page you can backup, upload or delete the settings and configuration.

**Backup settings** - backup or upload values from Settings page.

**Backup calibration** - backup or upload values from Calibration page.

**Backup Outputs&Alerts** - backup or upload values from Outputs and Alerts pages together.

**Delete Outputs&Alerts** - delete all the values from Outputs and Alerts pages together.

**Change password** - redirects user to a form for username and password change

## **Username and password change**

On the maintenance page, use the "Change password" button to go to the form to change your username and password. We strongly recommend that you enter this form only in HTTPS encrypted communication mode, see the Settings chapter.

1. For any change, it is always necessary to fill in the existing password name. The default setting is the name and password "grdw", written without quotation marks.
2. To change your username, enter the new name in the "New username" field.
3. To change your password, enter a new password in the "New password" and "Retype password", both fields must match. The password must not contain a colon at any place and space at the beginning or at the end.
4. It is possible to change the name and password at the same time, but it is not required by the system.
5. After pressing "Submit" wait 1-2 minutes, Growduino will restart. Restart is completed when "Connected" appears on the display.

## **GrowRoom - WebCam**

On the GrowRoom page You can watch a live stream from the monitored space using USB WebCam.

The video stream has a fixed resolution, frame rate and bitrate, and it's MJPEG type. The amount of data transferred is about 25MB/minute, the speed is 3.3Kbps, so be careful when checking via a FUP connection, typically a mobile operator.

The supplied webcam has replaceable ND filters. You can pull off a plastic ring and use a filter that matches the light intensity.

Video transmission works only when HTTPS is turned on, see the "Settings" page.

## Troubleshooting

1. If "Starting done ..." appears on the display after the start of Growduino for more than two minutes and "Connected" does not appear, press the 2x shortly the blue RESET button on the side of Growduino. The device restarts with default settings and should work properly.
2. If the browser does not load the page at all, try if you reach the Growduino by ping command: open a command prompt, in Windows you will usually find it in the Start-> Programs-> Accessories-> Command Prompt menu. Type "ping 192.168.x.xxx" (without the quotation marks) and replace x with your Growduino IP address. You should get 4 answers. If you don't get all 4 or even if the answer to all pings is "Request timed out." , please contact your IT professional or technical support at [support@growduino.cz](mailto:support@growduino.cz) .
3. If your browser does not load the whole page but only its part or if a saved setting is missing which you know it exists, delete cache of your browser. Then reload the page and it should be complete.
4. If you know that you have saved an incorrect setting on the OUTPUTS or ALERTS page and it can not be repaired via the browser or restart, contact [support@growduino.cz](mailto:support@growduino.cz) for technical support.
5. If you know that you have saved an incorrect setting on the SETTINGS page, Growduino is not available on the network and it is not possible to fix it through the browser or by restart, reset the Growduino to default settings. See the Settings chapter for the procedure.
6. If an incorrect time is displayed in the browser on the right side of arrow buttons on the Sensors page, or if Relays History shows incorrect time, or if charts are not displayed during the browsing previous periods, your Growduino may have set the wrong time. Check the settings on the SETTINGS page, especially "Gateway", "NTP Server" and "Time zone". Growduino will set the time automatically if the settings on the SETTINGS page are correct and if an internet connection is available. It is currently not possible to set the time manually.



## Further information

### Scale, resolution and accuracy of sensors

Name	Scale	Resolution	Accuracy
Light	0-100 units	0,1 unit	1 unit
DHT22	-40°C - +80°C / 0-100% RH	0,1°C / 0,1% RH	+0,5°C / +-2% RH
Temp Water	-10°C - +85°C	0,1°C	+0,5°C
Temp Bulb	-10°C - +85°C	0,1°C	+0,5°C
USND	6-200 cm	1cm	1cm
EC	0,3-8 EC	0,01 EC	0,1 EC
pH	0-14 pH	0,01 pH	0,1 pH
CO2	0-32000 PPM	10 PPM	10 PPM

### Resistance

Název	Water/humidity	Temperature	Dust	Notes
Basic unit Growduino	0-50% RH	-10°C - +50°C	partially resistible	Water must not condense and run over connecting ports of sensors and ETH, temperature must not fall below <a href="#">condensation point</a> , ports must not clog with dust .
Sensor Light	0-90% RH	-10°C - +80°C	partially resistible	Water must not condense, temperature must not fall below <a href="#">condensation point</a> , ports must not clog with dust.
Sensor DHT22	0-90% RH	-10°C - +80°C	not resistible	Water must not condense, temperature must not fall below <a href="#">condensation point</a> , ports must not clog with dust.
Sensor Temp Water	vodotěsné	-10°C - +85°C	resistible	Waterproof from the metal tube-up to beginning of the flat cable.
Sensor Temp Bulb	0-90% RH	-10°C - +85°C	partially resistible	Water must not condense, temperature must not fall below <a href="#">condensation point</a> , ports must not clog with dust.
Sensor USND	0-90% RH	-10°C - +50°C	not resistible	Water must not condense, temperature must not fall below <a href="#">condensation point</a> , ports must not clog with dust.
Sensor PH	0-90% RH	+1°C - +50°C	partially resistible	Water must not condense, temperature must not fall below <a href="#">condensation point</a> , ports must not clog with dust. The probe is water resistant and must not freeze.
Sensor EC	0-90% RH	+1°C - +50°C	partially resistible	Water must not condense, temperature must not fall below <a href="#">condensation point</a> , ports must not clog with dust. The probe is water resistant and must not freeze.
Sensor CO2	0-90% RH	-10°C - +50°C	not resistible	Water must not condense, temperature must not fall below <a href="#">condensation point</a> , ports and sensor itself must not clog with dust.

## **Electric safety**

Growduino was made according to correct technical practice from the standpoint of safety principles valid in European associations and if correctly installed, maintained and used to purpose for which it was produced, it should not put any person, pet, farm animal or property in danger. Growduino has not yet been tested by a certified authority and it is not as yet marked with CE Conformity Declaration. When it is required to open the basic unit of Growduino, it is important to first switch the device off, and disconnect from the mains. If Growduino is supplied via external UPS, it is important to disconnect it from the UPS also before the main unit is open.